accomplished—not, perhaps, yet awhile. Society may not yet require them; the world could not at present afford to pay for them. The progress of engineering works, if we consider it, and the expenditure upon them, has already in our time been prodigious. One hundred and sixty thousand miles of railway alone, put into figures at £20,000 a mile, amounts to £3,200,000,000 sterling; add 400,000 miles of telegraph at £100 a mile, and £100,000,000 more for sea-canals, docks, harbors, water and sanitary works constructed in the same period, and we get the enormous sum of £3,340,000,000 sterling expended in one generation and a half on what may undoubtedly be called useful works. The wealth of nations may be impaired by expenditure on luxuries and war; it cannot be diminished by expenditure on works like these.

As to the future, we know we cannot create a force; we can, and no doubt shall, greatly improve the application of those with which we are acquainted. What we called inventions can do no more than this, yet how much every day is being done by new machines and instruments! The telescope extended our vision to distant worlds. The spectroscope has far outstripped that instrument, by extending our powers of analysis to regions as remote. Postal deliveries were and are great and able organizations, but what are they to the telegraph? Need we try to extend our vision into futurity farther? Our present knowledge, compared with what is unknown even in physics, is infinitesimal. We may never discover a new force—yet, who can tell?

INSECTIVOROUS PLANTS.

By E. R. LELAND.

MOST amateur botanists have in the course of their walks come upon the peculiar leaves of the common sundew (*Drosera rotundifolia*), with the clear drops which the leaves bear glistening in the morning sun, and, on referring to their manuals, have noted the relationship which it bears to Venus's fly-trap (*Dionæa muscipula*), whose famous irritability is always a matter for mention.

In collecting the showy side-saddle-flower (*Sarracenia purpurea*), they have, of course, observed that its curious, trumpet-shaped leaves are usually half-filled with water and drowned insects.

In fishing from the stagnant pools, the inconspicuous, yellow blossoms, and rootless capillary leaves of the bladderwort (*Utricularia vulgaris*), they have doubtless noticed how they swarmed with insects and small crustaceans; and have accepted, with that unhesitating faith which our whole system of education begets and fosters, the statement that the little bladders are filled with air, and that their function is to float the plant at the time of flowering.

Possibly they may have noticed that the sticky leaves of the butterwort (*Pinguicula vulgaris*) are sometimes strongly incurved.

If, observing these matters, they have given them but a passing thought; have failed to see the relation, or apprehend the motives of the phenomena; and are surprised some day by learning that they point to one of the most wonderful discoveries of modern biology—they need reproach themselves with no exceptional heedlessness or obtuseness, for they have the illustrious company of most of the famous botanists from Linnæus down to those of the present generation.

Some attention has recently been called to the carnivorous habits of what Dr. Hooker calls "our brother-organisms—plants," by the appearance in different scientific periodicals of some brief note, or paper, by occasional observers; and more generally by Prof. Gray's papers which appeared in the *Nation*, April, 1874, pp. 216, 232, in which he announced some of the facts that had been communicated by Mr. Darwin and others. Some of these statements must, it should be said, be modified in the light of later observations.

It has turned out, as so often it does, that some of the more obvious observations and conclusions were made and drawn long ago, and recorded only to be overlooked and forgotten. The subject has a history running back a century or more. It is of more than common interest, and has been well told by Dr. Joseph Hooker, in his address to the department of Zoölogy and Botany, British Association, Belfast, August, 1874. Much condensed, it is as follows:

Dionœa.—About 1768, Ellis, a well-known English naturalist, sent to Linnæus a drawing of a plant, to which he gave the poetical name of *Dionœa.* "The plant," wrote Ellis, "shows that Nature may have some views toward its nourishment in forming the upper joint of its leaf like a machine to catch food; upon the middle of this lies the bait for the unhappy insect that becomes its prey. Many minute red glands that cover its surface tempt the animal to taste them; and, the instant these tender parts are irritated by its feet, the two lobes rise up, grasp it fast, lock the rows of spines together, and squeeze it to death. And further, lest the strong efforts for life in the creature, just taken, should serve to disengage it, three small spines are fixed near the middle of each lobe, among the glands, that effectually put an end to its struggles. Nor do the lobes ever open again while the dead animal continues there. It is nevertheless certain that the plant cannot distinguish an animal from a vegetable or mineral substance; for, if we introduce a straw or pin between the lobes, it will grasp it fully as fast as if it were an insect."

This account, substantially correct, but erroneous in some particulars, led Linnæus to declare that, though he had seen and examined no small number of plants, he had never met with so wonderful a phenomenon. He was, however, too sagacious to accept Ellis's account of the *coup-de-grâce* which the insects received from the three stiff hairs in the centre of each lobe of the leaf. He was also unable to bring himself to believe that Nature intended the plant "to receive some nourishment from the animals it seizes," and he accordingly declared that, as soon as the insects ceased to struggle, the leaf opened and let them go. He only saw in these wonderful actions an extreme case of sensitiveness in the leaves; and he consequently regarded the capture of the disturbing insects as merely accidental, and of no importance to the plant.

Linnæus's authority caused his statements to be faithfully copied from book to book.

Sixty years after Linnæus wrote, an able botanist, the Rev. Dr. M. A. Curtis (who died in 1872), lived at Wilmington, North Carolina, the headquarters of this very local plant. In 1834 he published an account of it in the *Boston Journal of Natural History*, which is a model of accurate scientific observation. He said: "Each half of the leaf is a little concave on the inner side, where there are placed three delicate, hair-like organs, in such order that an insect can hardly traverse it without interfering with one of them, when the two sides suddenly collapse, and inclose the prey, with a force surpassing an insect's efforts to escape. The fringes of hairs on the opposite sides of a leaf interlace like the fingers of two hands clasped together. The sensitiveness resides only in these hair-like processes on the inside, as the leaf may be touched or pressed in another part without sensible effects. The little prisoner is not crushed and suddenly destroyed, for I have often liberated captive flies and spiders which sped away as fast as fear or joy could carry them. At other times, I have found them enveloped in a fluid of mucilaginous consistence which seems to act as a solvent, the insects being more or less consumed in it. This circumstance has suggested the possibility of their being made subservient to the nourishment of the plant through an apparatus of absorbent vessels in the leaves."

To Ellis belongs the credit of divining the purpose of the capture of insects by the *Diònœa*. But Curtis made out the details of mechanism by ascertaining the seat of the sensitiveness of the leaves; and he also pointed out that the secretion was not a lure exuded before the capture, but a true digestive fluid poured out like our own gastric juice after the ingestion of food. (Prof. Gray quotes Dr. Curtis's observations on the *Dionœa* in his "Genera of the Plants of the United States," vol. i., p. 196, 1849, without comment; and his plate of the plant does not show any of the important sensitive spines.)

The investigation of this curious question again rested until 1868, when it was taken up by Mr. Canby, who was then staying in the *Dionæa* district. He found that the leaf had the power of dissolving animal matter, and that small pieces of beef that were fed to it were completely dissolved and absorbed; the leaf opening again with a dry surface and ready for another meal, though with an appetite somewhat jaded. It not only could be surfeited, but it suffered from indigestion; and a meal of cheese disagreed with the leaves so seriously as finally to kill them.

Finally, Dr. Burdon-Sanderson has made an important contribution to this investigation, by demonstrating the correspondence between the electrical phenomena which accompany muscular action and those which are associated with the closing of the Dionæa-leaf. He has shown that, not alone in the electrical but in structural changes which ensue, the resemblance is complete between the contraction of muscle and that of the leaf; and, the further the inquiry is pursued, the more striking does the resemblance appear.

Drosera.—Unlike the preceding genus, which is confined to a single district, the sundews are widely distributed. The fact that they are closely related to the *Dionæa* was little known when the curious habits, which are now attracting so much attention, were first discovered.

Mr. Gardom, a Derbyshire botanist, gives an account of what his friend Mr. Whateley, an eminent London surgeon, made out in 1780: "On inspecting some of the contracted leaves we observed a small insect very closely imprisoned therein, which occasioned some astonishment as to how it happened to get into so confined a situation. Afterward, on Mr. Whateley's centrically pressing with a pin other leaves yet in their natural and unexpanded form, we observed a remarkably sudden and elastic spring of the leaves, so as to become inverted upward, and, as it were, encircling the pin, which evidently showed the method by which the fly came into its embarrassing situation."

This account, which is erroneous in representing the movement of the hairs as much more rapid than it really is, must have been written from memory.

In July of the preceding year (though the account was not published till two years afterward), Roth, in Germany, had remarked, in *Drosera rotundifolia* and *longifolia*, that "many leaves were folded together from the point toward the base, and that all the hairs were bent like a bow." Upon opening these leaves, he says: "I found in each a dead insect; hence I imagined that this plant, which has some resemblance to the *Dionæa muscipula*, might also have a similar moving power. . . . With a pair of pliers I placed an ant upon the middle of the leaf of *D. rotundifolia*. The ant endeavored to escape, but was held fast by the clammy juice at the points of the hairs, which was drawn out by its feet into fine threads. In some minutes, the short hairs on the disk of the leaf began to bend, and in some hours the end of the leaf was so bent inward as to touch the base. The ant died in fifteen minutes, which was before all the hairs had bent themselves."

These facts, established nearly a century ago, by the testimony of independent observers, have up to the present time been almost ignored.

More recently, however, they have been repeatedly verified: in Germany, by Nilschke, in 1860; in this country by L. A. Millington, a correspondent of the *American Naturalist*, April, 1868; by Mrs. Treat, of New Jersey, *American Journal of Science*, November, 1871, and *American Naturalist*, December, 1873; by Mr. A. W. Bennett, at the meeting of the British Association for the Advancement of Science, 1873.

It is noticeable that all of these observers unite in reporting one erroneous conclusion, namely, that the movements do not result when inorganic substances are placed upon the leaves. Darwin's experiments show that although the effect is not so great and the substances are not so long detained, yet such bodies as bits of cinder do possess the power of irritation.

Mrs. Treat also reported that, when a living fly was pinned at a distance of half an inch from the leaves of the *D. filiformis*, the leaves bent toward it and reached it in an hour and twenty minutes. Mr. Darwin was not only unable to obtain any similar results, but, to admit that this motion was any thing other than an accident, would compel him to adopt some other theory than the one he now holds to account for the transmission of the impulse to motion.

Reference may here be made to a remarkable statement in a note of M. Ziegler to the Paris Academy of Sciences, in 1872. He says: "In studying these remarkable plants, I noticed that all the albuminoid animal substances, if held for a moment between the fingers, acquired the property of making the hairs of the *Drosera* contract. I also observed that such substances, when they had not been in contact with a living animal, had no visible action on the hairs. This shows that the simple contact of the fingers communicates to inert animal substances a property which they did not possess before." Repeated experiments, in which every precaution was taken by Mr. Darwin, seem effectually to negative this extraordinary belief of M. Ziegler.

This, then, is a brief review of the subject up to the recent publication of Mr. Darwin's book upon it. It has for some time been known, to all who have followed the question, that he was engaged in researches that would one day be published, and they have been waiting for them with eager interest. With characteristic patience and caution, it is only after fifteen years of careful investigation that he puts forth the results of the long series of observations. As one reads the book, the most vivid impression made is by the wonderful amount of painstaking labor that the record of the experiments shows. Like the artist of Kouroo, he seems to have said to himself: "Time is an ingredient that enters into no perfect work; and my work shall be perfect in all respects, though I should do nothing else in my life." And, lo!

while the task which he set to himself was to answer the question, "Why the *Drosera* caught such numbers of insects," the result has been the most valuable contribution to botanical literature which this age has seen. Competent critics pronounce it more important than his works on the "Fertilization of Orchids," and the "Movements and Habits of Climbing Plants;" and in scientific research there is, for Mr. Darwin, no higher standard of comparison than to compare him with himself.

The greater part of the book is given to the record of observations on the phenomena shown by *Drosera rotundifolia*. This well-known plant bears from two or three to five or six leaves, generally extended more or less horizontally, but sometimes extending vertically upward. The shape and general appearance are shown, as seen from above, in Fig. 1:

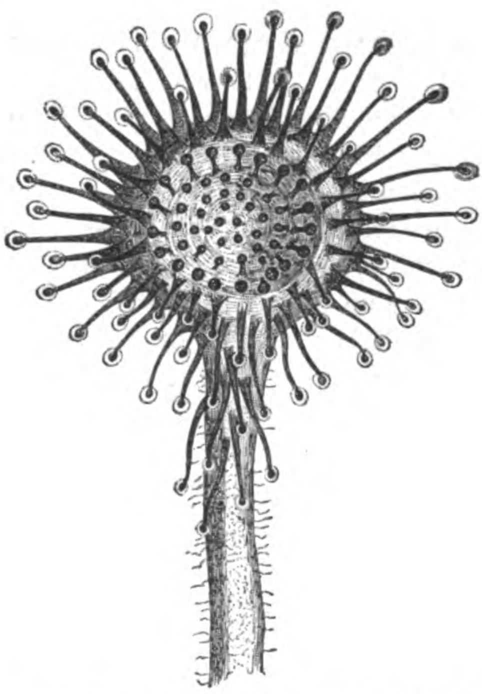

FIG. 1.—DROSERA ROTUNDIFOLIA.—Leaf viewed from above; enlarged four times.

The leaves are commonly a little broader than long; the whole upper surface being covered with gland-bearing filaments, or tentacles, as Mr. Darwin calls them, from their manner of acting.

A tentacle consists of a thin, straight, hair-like pedicel, carrying a gland on the summit. Each gland is surrounded by a large drop of extremely viscid secretion; they average about two hundred on each leaf, and as they glitter in the morning sun have given to the plant its poetical name. The tentacles on the central part of the leaf are short and stand upright, and their pedicels are green. Toward the margin they become longer and longer and more inclined outward, with their pedicels of a purple color. Those on the extreme margin project in the same plane with the leaf, or more commonly (*see* Fig. 2) are considerably reflexed.

If a small object be placed on the glands in the centre of the leaf, a motor impulse is transmitted to the marginal tentacles. The nearer ones are first affected, and then those farther off, until at last all are slowly but unerringly inflected, and close over the object. This takes place in from one to five or more hours; the difference in time de-

FIG. 2.—DROSERA ROTUNDIFOLIA.—Old leaf viewed laterally; enlarged about five times.

pending on several circumstances, as the size of the object and its nature; on the vigor and age of the leaf; whether it has lately been in action; and the temperature.

The tentacles in the centre do not become inflected when directly excited, though they are capable of inflection if excited by a motor impulse from other glands; but through and from them the motor impulse spreads gradually on all sides. Such is not the case with the marginal tentacles. If a bit of meat be placed on one of these it quickly transmits an impulse to its own bending portion, but never to those adjoining (*see* Fig. 5), for these are never affected until the meat has been carried to the central glands, which then radiate their conjoined impulse on all sides.

The sensitiveness of the leaves is located in the glands together with the immediately underlying cells of the tentacles. Though it is necessary that the glands should be touched, it is wonderful how slight a pressure will suffice. A bit of human hair $\frac{1}{50}$ of an inch in length and weighing only $\frac{1}{78740}$ of a grain will induce motion, transmit a motor impulse through the whole length of a marginal tentacle, and cause it to sweep through an angle of 180° or more. This minute morsel, it must be borne in mind, rests upon and is supported by the dense, viscid fluid which surrounds the gland, and the pressure is thus rendered inconceivably slight. Mr. Darwin conjectures that it may be less than the millionth of a grain. While the pressure may be extremely slight, it needs must be steady. A sharp, sudden brush of the tentacles does not induce inflection, nor do drops of water falling upon the glands from any height. This specialized nature of the sensitiveness may readily be seen to be of great use to the plant, effecting an economy of time and energy, for the process of inflection is slow and that of reëxpansion still slower, often occupying many hours, and even days. It should be mentioned that, when excited by soluble matter of the proper kind, not only the tentacles, but the disks, are inflected and close in about the object. There is thus formed out of the leaf a stomach; a comparison that Mr. Darwin has proved to be no fanciful one. Space will not permit giving even examples of his exhaustive experiments; to the book itself must be referred those who may doubt their thoroughness, or question the conclusions drawn from them.

Fig. 3.—Drosera rotundifolia.—Leaf (enlarged) with all the tentacles closely inflected.

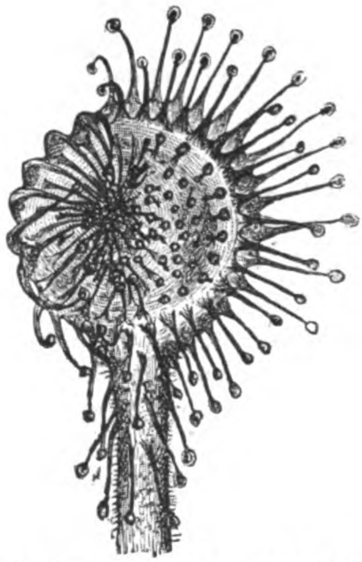

Fig. 4.—Drosera rotundifolia.—Leaf (enlarged) with the tentacles on one side inflected over a bit of meat.

It is proved that the leaves are capable of true digestion, and that the glands absorb the digested matter. The correspondence between the secretion of the *Drosera* and the gastric juice of animals is shown in that which it fails to digest as well as that which it succeeds in digesting. As is well known, the gastric juice contains an acid and a ferment, both of which are requisite for digestion; so it is with the secretion of *Drosera.* When the stomach of an animal is mechanically irritated, it secretes an acid; when bits of glass are put on the glands of *Drosera*, the secretion and that of the surrounding glands are increased in quantity and become acid. The stomach of an animal, however, does not secrete its proper ferment, pepsin, until certain substances called peptogenes are absorbed; matter must be absorbed by the glands of *Drosera* before they secrete their proper ferment. Like gastric juice, the secretion of *Drosera* has antiseptic properties. Meat is dissolved by each in the same manner and by the same stages. It promptly dissolves cartilage, a substance so little affected by water. It dissolves bone, and even the enamel of teeth. In short, there is no doubt that the ferment in both cases is closely similar if not identically the same, a fact in physiology which may well be called wonderful!

When it is considered where the plant grows—generally on extremely poor, peaty soil—it is evident that the supply of nitrogen would be quite deficient unless the plant had the power of obtaining this important element from captured insects, and we can thus understand how its roots are so poorly developed. These usually consist of only two or three slightly divided branches from half to one inch in length, furnished with absorbent hairs: it appears that they serve only to imbibe water, though, of course, they will absorb nitrogenous matter when supplied.

Confirmation of these statements is furnished by some experiments, concluded since the publication of Mr. Darwin's book, by Mr. Lawson Tait, an account of which he sends to *Nature*, July 29, 1875, p. 251. Only the results can be stated, and those briefly: "It is certain that the sundew not only absorbs nutriment by its leaves, but that it can actually live and thrive by their aid alone (that is, without the aid of roots); that nitrogenous matter is more readily absorbed by the leaves than by the roots, for over-feeding kills the plant sooner by the leaves alone than by the roots alone."

Mr. Tait also announces that from the secretion of *Drosera dichiotoma* he has been able to separate a substance closely resembling pepsin.

If a tentacle receives an impulse from its own glands the movement is always toward the centre of the leaf (Fig. 5).

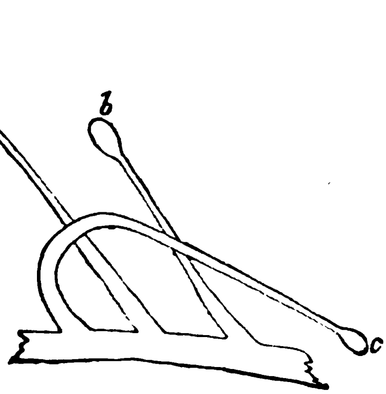

FIG. 5.—DROSERA ROTUNDIFOLIA.—Diagram showing one of the exterior tentacles closely inflected; the two adjoining ones in their ordinary position.

On the other hand, when the motor impulse comes from one side of the disk, the surrounding tentacles, including the short central ones, all bend with precision toward the point of excitement, wherever this may be seated. This is in every way a remarkable phenomenon; for the leaf falsely appears as if endowed with the senses of an animal (*see* Fig. 4).

In every case the impulse from a gland has to travel for at least a short distance to the basal part of the tentacle, the gland being carried solely by the inflection of the lower part. When the central glands are stimulated, and the extreme marginal tentacles become inflected, the motor impulse is transmitted across half the diameter of the disk. It passes not along the vascular system, but through the cellular tissue, traveling more rapidly and easily in a longitudinal than in a transverse line, probably for the reason that the cells are elongated longitudinally, and some obstruction is encountered at each cell-wall through which the motor impulse must pass.

A molecular change of the protoplasm within the cells, to which Mr. Darwin has given the name of aggregation, precedes and accompanies all motion. When a leaf which has not been excited or inflected is examined, the cells forming the pedicels are seen to be filled with an homogeneous purple fluid. If the tentacle be examined some hours after having been excited, the purple matter is found to be aggregated into masses of various shapes suspended in a colorless fluid. The change begins within the glands and travels downward, being arrested for a short time at each cell-wall; the aggregated masses perpetually changing form, separating and uniting. After the cause of the excitement has been removed, and the tentacles have reëxpanded, the colored masses of protoplasm are redissolved, and the purple fluid again becomes homogeneous and transparent. This process of aggregation is not dependent upon the inflection of the tentacles or increased secretion of the glands—a most remarkable feature of the phenomenon being that in the tentacles which are inflected by an indirect irritation, conveyed by motor impulse from other glands, some influence is sent up to the glands, as their secretion is increased and becomes acid; then the glands thus excited send back some other action, causing the protoplasm to aggregate in cell beneath cell. There can actually be seen a molecular change proceeding, which may be somewhat similar to the molecular change which is supposed to be sent from one end of a nerve to another when sensation is felt. We have here a reflex action, and the only known case thereof in the vegetable kingdom. The rate at which the motor impulse is transmitted is much slower than in animals. This fact, as well as that of the motor impulse not being specially directed to certain points, are both, no doubt, due to the absence of nerves. Nevertheless, we perhaps see the prefigurement of the formation of nerves in animals in the transmission of the motor impulse being much more rapid down the confined space within the tentacles than elsewhere, and somewhat more rapid in a longitudinal than in a transverse direction across the disk.

Of course, there is not in this, or in the reflex action, any thing comparable with the nervous systems of animals, and, as Mr. Darwin says, "the greatest inferiority of all is the absence of a central organ, able to receive impressions from all points, to transmit their effects in any definite direction, to store them up and reproduce them." That is to say, *Drosera* seems to be without even the prefigurement of a brain, and we can almost fancy that we detect a trace of disappointment or regret in this admission.

A wide range of experiment shows that probably all the species of *Drosera* are adapted for catching and digesting insects by nearly the same means, though not with equal development or completeness.

Dionæa muscipula.—The form of the bilobed leaf which is the most wonderful feature of this wonderful plant, already described, may be seen from the accompanying sketch.

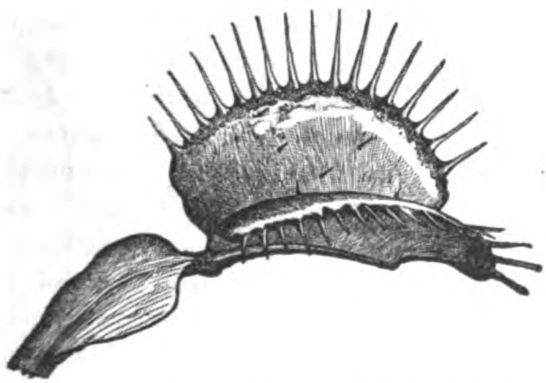

FIG. 6.—DIONÆA MUSCIPULA.—Leaf viewed laterally in its expanded state.

In the *Dionæa* the locality of sensitiveness is the three filaments which appear on each half of the upper surface of the leaf. It is unlike *Drosera* in that the filaments are sensitive to sudden impact, the transmission of the impulse is more rapid and the consequent movement instantaneous. Another point of unlikeness consists in the power of secretion of the glands, those of *Dionæa* being only excited by the absorption of nitrogenous matter. When any substance comes in contact with the filaments, the lobes of the disk close instantly upon it, confining it in a concave chamber; if the imprisoned matter be nitrogenous the lobes are gradually pressed closer together, the glands secrete freely and reëxpansion takes place only after from nine to twenty-four days, when nearly all trace of the substance will have disappeared, and sensitiveness is lost, only to reappear after some time has elapsed, if at all. If, however, the closing is the result of sudden impact or of the contact of a non-nitrogenous substance, the leaf shortly opens again and is at once sensitive, the glands showing no signs of secretion. The constitution and action of the secretion are identical with those of *Drosera*, as is probably the manner of transmission of the motor impulse. But want of space again excludes many interesting details.

Aldrovanda, *Drosophyllum*, *Roridula*, and *Byblis*, four other genera of the same order, all are provided with secreting glands and seem to have similar powers, though in a lesser degree.

Mr. Darwin was also led to investigate the habits of *Pinguicula* *vulgaris*, the result being to establish beyond question the predatory practices of the bladderwort, a plant which had hitherto enjoyed a good name.

It is not provided with any irritable filaments, the sensitiveness residing in the surface of the leaf, which is set with two kinds of glandular hairs secreting an extremely viscid fluid which seems to be the only agent for entrapping the insects. When once caught they are detained by the slowly-inflecting leaf. Here, too, contact with nitrogenous bodies changes the nature of the secretion, so that it becomes

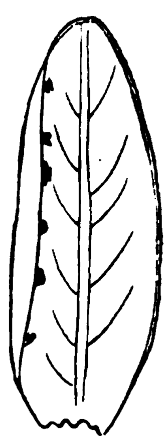

FIG. 7.—PINGUICULA VULGARIS.—Outline of leaf with left margin inflected over a row of small flies.

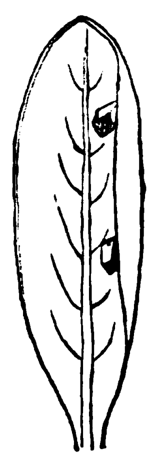

FIG. 8.—PINGUICULA VULGARIS.—Outline of leaf, with right margin inflected against two square bits of meat.

capable of dissolving and digesting insects and other nutritious substances, when the secretion and the digested matter are reabsorbed by the glands. When the objects are too large to be inclosed by the inflected leaf, they are by its incurving pushed along over the surface, constantly coming in contact with fresh and hungry glands, subserving the needs of the plants as well as by the other method (*see* Fig. 8).

Utricularia neglecta and U. vulgaris (common Bladderwort).—It will be a new revelation to most readers to be told that the bladders of this plant are not, as the manuals have always stated, filled with air and intended to float the plant, but that their real use is to capture small aquatic animals, which they do on a large scale.

The general appearance of a bladder is shown in the figure (10) given below. The lower side is straight, the other surface convex and terminating in two long prolongations bearing six or seven long pointed bristles. The prolongations are called antennæ, for, as Mr. Darwin says, "the whole bladder curiously resembles the entomostracean crustacea" upon which they prey so freely.

Under these antennæ, where the bladder is slightly truncated, is situated the most curious and important part of the whole structure, namely, the entrance and valve.

The valve is attached on all sides to the bladder, excepting by its posterior margin, which is very thin, and rests on a collar or rim, which dips deeply into the bladder. The valve can only open in-

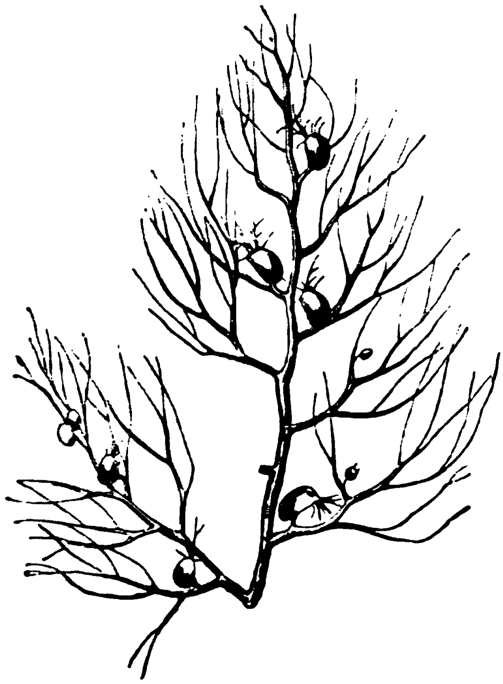

FIG. 9.—UTRICULARIA NEGLECTA.—Branch with the divided leaves bearing bladders; about twice enlarged.

ward; there are on its surface numerous glands, which have the power of absorption, but are not known to secrete.

The whole inner surface of the bladder is covered with a serried mass of processes, consisting each of four divergent arms, whence they

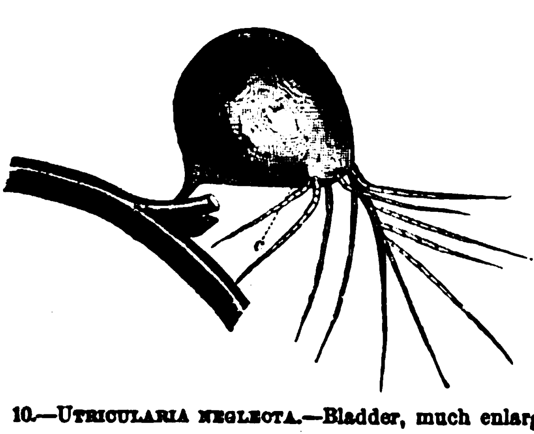

FIG. 10.—UTRICULARIA NEGLECTA.—Bladder, much enlarged.

are called quadrifid processes. Each arm generally contains a minute, faintly-brown particle, either rounded or elongated, which shows incessant Brownian movements.

Whenever found in stagnant water the bladders swarm with insects, crustaceans, larvæ, and fresh-water worms, in various stages of decay. The animals enter the bladder by bending in the free edge of the valve, which shuts again instantly. How it is that such weak and minute animals get into the bladders is not yet understood, but they do succeed in entering as do inanimate objects, if laid upon the valve. The locality of the irritability, if indeed there be any, is not determined.

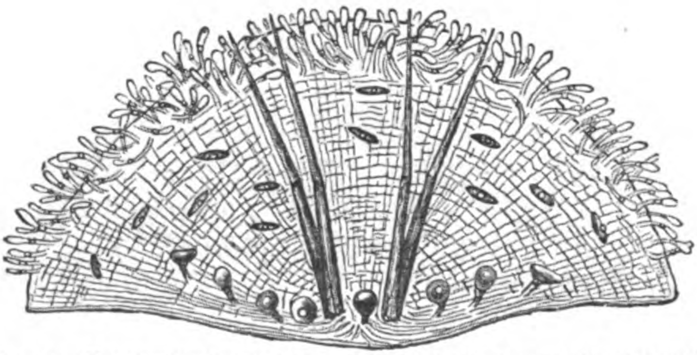

FIG. 11.—UTRICULARIA NEGLECTA.—Valve of bladder, greatly enlarged.

Notwithstanding the elaborate mechanism for the capture of animal food, there seems to be no power of digesting it, nor for hastening its decay; although, when decomposition sets in, its products are slowly absorbed by the quadrifid processes; at least, these processes from bladders containing decayed animals generally show masses of spontaneously-moving protoplasm which do not appear in those taken from clean bladders.

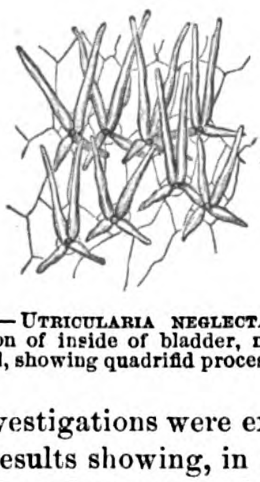

FIG. 12.—UTRICULARIA NEGLECTA.—Small portion of inside of bladder, much enlarged, showing quadrifid processes.

FIG. 13.—UTRICULARIA NEGLECTA.—One of the quadrifid processes greatly enlarged.

Investigations were extended to many other species of *Utricularia*, with results showing, in all cases, an adaptation for capturing small animals and power to absorb the products of their decay.

To be classed with this genus, as being insectivorous to a similar extent, are *Sarracenia* and *Darlingtonia*. Upon these Mr. Darwin records no observations.

Sarracenia variolaris has, however, had its powers carefully investigated by Dr. Mellichamp, of Bluffton, South Carolina. This species differs from the common Northern one (*S. purpurea*) chiefly in having a lid which closes over the mouth of the trumpet-shaped leaves, so that rain can not readily enter. The leaves are usually half-filled with a fluid which Dr. Mellichamp is satisfied is secreted at the bottom of the tubes. He describes it as mucilaginous, and leaving in the mouth a peculiar astringency. In it meat decomposes more rapidly than in water, and he concludes that as the leaves when stuffed with insects become most disgusting in odor, we have to do with an accelerated decomposition, though not with digestion. He attributes anæsthetic effects to the fluid. The lure which brings the insects to the mouth of the pitcher is a honey-baited pathway running from the ground along the broad wing of the pitcher to its mouth, up which the insects are lured to their fate. Nothing of this kind is observed in *S. purpurea*, and its exposed mouth is so placed that rain must fall into it. It is not probable, as Dr. Hooker says, that pitchers presenting such differences should act similarly, and he adds: "The fact that insects normally decompose in the fluid of all would suggest the probability that all feed on the products of decomposition; but as yet we are ignorant whether the glands within the pitchers are secretive or absorptive, or both; if secretive, whether they secrete water or a solvent; if absorptive, whether they absorb animal matter or the products of decomposition."

Prof. C. V. Riley (American Association for the Advancement of Science, 1874) is of opinion that the only benefit to the plant is from the liquid manure.

But this fascinating subject cannot be pursued further.

Sentimental flower-worshipers, fond of quoting the pretty metaphor of their buds and blossoms being "truly the language of angels," will doubtless be pained to learn that they are not all ethereal creatures subsisting on such lovely foods as dew and sunlight, but that they are at times given to dining off the more substantial fricassees which their alert tentacles know so well how to prepare. And although they may consign the sanguinary *Droseras* and *Dionæas* to the limbo of the unclean, and turn with renewed admiration to their own floral pets, still the matter does not end here. Mr. Darwin throws out some dark hints as to the private lives of the immaculate *Primula*, the brilliant *Pelargonium* and other greenhouse favorites, that must lead the thoughtful mind to conclude that that they will at least bear watching.

Seriously, these revelations afford abundant food for thought. There are three remarkable powers connected with the phenomenon: the movement of the leaves when excited; the secreting of a digestive fluid; the absorption of digested matter. The species possessing them all hold them in different degree; some possess two and others but one of them. What light can natural selection throw upon the

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steps by which these wonderful powers were gradually acquired? is one of the problems presented to the evolutionist.

Mr. Darwin submits his work wonderfully advanced when compared with the state in which he found it, but there remains much to be done.

INDUCED DISEASE FROM THE INFLUENCE OF THE PASSIONS.[1]

By B. W. RICHARDSON, M. D., F. R. S.

MANY of the forms of disease previously detailed may be induced by other causes than worry or mental strain. They may be the effects of the unrestrained influence of certain of the passions. I say certain of the passions, because all do not seem to act with the same intensity. Some of them act with a sharpness of intensity that is peculiar, while others apparently excite no physical injury.

The passions which act most severely on the physical life are anger, fear, hatred, and grief. The other passions are comparatively innocuous. What is called the passion of love is not injurious until it lapses into grief and anxiety; on the contrary, it sustains the physical power. What is called ambition is of itself harmless; for ambition, when it exists purely, is a nobility lifting its owner entirely, from himself into the exalted service of mankind. It injures when it is debased by its meaner ally, pride; or when, stimulating a man to too strenuous efforts after some great object, it leads him to the performance of excessive mental or physical labor and to the consequences that follow such effort.

The passion called avarice, according to my experience, tends rather to the preservation of the body than to its deterioration. The avaricious man, who seems to the luxurious world to be debarring himself of all the pleasures of the world, and even to be exposing himself to the fangs of poverty, is generally placing himself in the precise conditions favorable to a long and healthy existence. By his economy, he is saving himself from all the worry incident to penury; by his caution he is screening himself from all the risks incident to speculation or the attempt to amass wealth by hazardous means; by his regularity of hours and perfect appropriation of the sunlight, in preference to artificial illumination, he rests and works in periods that precisely accord with the periodicity of Nature; by his abstemiousness in living he takes just enough to live, which is precisely the right thing to do according to the rigid natural law. Thus, in almost

[1] From advance sheets of a new work in press of D. Appleton & Co., entitled "The Diseases of Modern Life."